REMARKS

Claims 1-19, all the claims pending in the application, stand rejected on prior art grounds. Claims 5, 8, 10, 14, 17, and 19 stand rejected upon informalities. Claims 1 and 11 stand objected to as introducing new matter. Moreover, the title, abstract, and drawings stand objected to. As such, Applicants herein amend claims 1, 8, 10, 11, 17, and 19, the title, the abstract, and the drawings. Applicants respectfully traverse these rejections based on the following discussion.

I. The Objection to the Title

The Office Action indicates that the title of the invention is not descriptive. As such, Applicants herein amend the title to provide clearer indication of the invention to which the claims are directed. In view of the foregoing, the Examiner is respectfully requested to reconsider and withdraw this objection.

II. The Objection to the Abstract

The Office Action indicates that the abstract is objected to because it does not set forth the nature and gist of the invention. As such, Applicants herein amend the abstract to provide clearer indication of the nature and gist of the invention to which the claims are directed. In view of the foregoing, the Examiner is respectfully requested to reconsider and withdraw this objection.

III. The Objections to the Drawings

The Office Action indicates that the Figures 1a-1b of the drawings are objected to because they should be designated by a legend such as --Prior Art--. As such, Applicants herein

submit corrected formal drawings, which designate Figures 1a-1b as --Prior Art-- in accordance with the suggestion in the Office Action. In view of the foregoing, the Examiner is respectfully requested to reconsider and withdraw these objections.

IV. The Objections to the Claims

Claims 8, 10, 17, and 19 because of informalities. Claims 5 and 14 stand rejected under 35 U.S.C. §112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which Applicants regard as the invention. As such, Applicants herein amend claims 8, 10, 17, and 19 to more clearly indicate the scope of the claim and to remove the purported vague language indicated in the Office Action. Moreover, Applicants have amended claims 1 and 11, from which claims 5 and 14 depend thereon, respectively. As a result of these amendments, the purported indefiniteness, suggested by the Office Action, in claims 5 and 14 are effectively removed. In view of the foregoing, the Examiner is respectfully requested to reconsider and withdraw these objections.

V. The Prior Art Rejections

Claims 1-19 stand rejected under 35 U.S.C. §102(b) as being anticipated by Nakajima, et al. ("Magnetoresistance Oscillations in Double Ferromagnetic Tunnel Junctions with Layered Ferromagnetic Nanoparticles," IEEE Transactions on Magnetics, Vol. 36, No. 5, 2000, pp. 2806-2808). Claims 1-19 stand rejected under 35 U.S.C. §103(a) as being unpatentable over applicants admitted prior art, in view of Black, et al. (U.S. Patent No. 6,162,532), hereinafter referred to as "Black." Applicants respectfully traverse these rejections based on the following discussion.

Nakajima, et al. (hereinafter referred to as "Nakajima") teaches tunnel magnetoresistance in double tunnel junctions with layered ferromagnetic nanoparticles. The sample produced in Nakajima comprises two ferromagnetic electrodes (CoFe/Fe) separated by an Al_2O_2 insulating layer in which layered $Co_{80}Pt_{20}$ nanoparticles are embedded. The nanoparticles are ellipsoidal with an average diameter of 3.7 nm, and composes a well-defined layer. At 10K, Nakajima observes magnetoresistance oscillation with respect to the bias voltage. The observed TMR oscillation, with a period of 1.6 mV, accompanies oscillations of the conductance. Nakajima considers that the conductance oscillation may originate from the single electron charging effect.

Black teaches a magnetic storage medium, which is formed from a layer of substantially uniformly spaced-apart magnetic nanoparticles of substantially uniform diameter disposed upon a surface of a substrate, with a coating, preferably of abrasion-resistant material, applied to adhere the nanoparticles to the substrate and to maintain their substantially uniform spaced-apart relationship. The nanoparticles are formed from a magnetic material selected from the group consisting of elements Co, Fe, Ni, Mn, Sm, Nd, Pr, Pt, Gd, an intermetallic compound of the aforesaid elements, a binary alloy of said elements, a ternary alloy of said elements, an oxide of Fe further comprising at least one of said elements other than Fe, barium ferrite, and strontium ferrite.

However, the claimed invention, as provided in amended independent claims 1 and 11 contain features, which are patentably distinguishable from the prior art references of record. Specifically, claims 1 and 11 recite, "...an organic spacer surrounding each of said chemically-synthesized magnetic nanoparticles, wherein a deviation between diameters of different ones of said nanoparticles is less than 15%," which are clearly not taught or suggested in the prior art of record.

With regard to differences between the claimed invention and Nakajima, Nakajima's nanoparticles are made by a process called sputtering, described on page 2806, section II of Nakajima: "The double tunnel barrier with structure, $Al_2O_3/Co_{80}Pt_{20}/Al_2O_3$, was prepared by alternatively sputtering from Al_2O_3 and $Co_{80}Pt_{20}$ targets. The higher surface energy of $Co_{80}Pt_{20}$ compared to that of Al_2O_3 leads to 3-dimensional nucleation of the deposit." In other words, the process for forming the nanoparticles in Nakajima's invention relies on the fact that $Co_{80}Pt_{20}$ is immiscible with Al_2O_3. The fact that these materials do not mix causes the formation of $Co_{80}Pt_{20}$ nanoparticles embedded in Al_2O_3. However, Nakajima's process only works for forming certain types of nanoparticles, because it relies on this immiscibility process. Conversely, the claimed invention is not limited as such because nanoparticles of many different types can be synthesized according to chemical methods taught by the claimed invention, and the composition of these nanoparticles is independent of the type of material used for the device insulating tunnel barrier, which in Nakajima's case is Al_2O_3, and in the case of the claimed invention is organic surfactant molecules. As such, the claimed invention's nanoparticles are chemically-synthesized, which will result in nanoparticles with a much higher degree of size uniformity than can be achieved via the nucleation/diffusion processes involved with deposition means such as sputtering, which distinguishes the claimed invention from Nakajima.

As shown in Figure 1(b) of Nakajima, the resulting nanoparticles have a wide distribution of shapes. Nakajima describes the nanoparticles shapes as ellipsoidal with a height of 2.5 nm, and a distribution of widths centered around 4.5 nm with standard deviation of 1 nm. This amounts to a distribution of nanoparticles sizes of 22% (1/4.5=0.22) (see generally Nakajima p. 2807, col. 1, paragraph 1). Because the nanoparticles are formed using a process which relies on material diffusion it is highly likely that all nanoparticles formed in this manner will have similar

distributions of nanoparticles sizes. At these small dimensions the magnetic properties of the nanoparticles are extremely sensitive to size; e.g., larger nanoparticles have different properties than smaller ones.

Although not detailed in Nakajima's description, a second consequence of forming nanoparticles by the diffusion process in Nakajima is that it not only inherently results in a distribution of nanoparticle sizes, but also results in a distribution of tunnel barrier thicknesses. This is clearly evident in looking at Figures 1(a) and 1(b) in Nakajima. Variations in tunnel barrier thickness will result in large changes in electrical resistance, as electron tunneling is exponentially-dependent of insulator thickness, which is contrary to the claimed invention because the claimed invention uses chemically-synthesized nanoparticles.

In other words, the reproducibility of electronic performance of devices containing small numbers of nanoparticles will rely on consistency in both nanoparticle sizes and insulator thickness. Again, the claimed invention addresses this issue by using chemical synthesis to precisely control nanoparticle size, and insulator thickness.

Another unique attribute of the claimed invention is the use of organic ligands to act as an insulating layer to separate the nanoparticles from both each other and the electrodes. Many other prior art references use inorganic materials (such as SiO_2) as the insulating layer to isolate the magnetic nanocrystals from the magnetic electrodes in the device. This choice is understandable as SiO_2 and other inorganics are commonly used in electronics applications. Thus, use of an organic insulator (spacer) is uncommon and would not be obvious to one of ordinary skill in the art.

Moreover, the claimed invention uses the organic ligand attached to the nanocrystal surface not only as the means to produce the nanocrystals, but also to serve as the insulating

layer to isolate the nanocrystals from the electrodes. As such, the claimed invention not only produces a device with performance advantages (due to greater flexibility in being able to tune the insulating properties of the organic insulator through chemistry) over Nakajima and the AAPA (Applicants' admitted prior art), but also represents a non-obvious distinction from the device of AAPA. In particular, the insulating spacer in these types of devices needs to not only isolate the nanocrystals from the electrodes and one another, but also needs to act as a tunnel barrier for electrons moving through the device. Furthermore, the insulator must not disturb the spin-coherence of the tunneling electrons. The idea that organic ligands can serve this specialized role supporting spin-coherent tunneling is not at all obvious in the scientific community, and is indeed a major element of distinction of the claimed invention.

To reiterate, the nanoparticles in the claimed structure are chemically-synthesized, rather than produced using another means. This is central to the claimed invention as it allows for control of the critical device dimensions via the high degree of size precision afforded by nanoparticle synthesis techniques. Figures 1(a) and a(b) of Nakajima clearly show a device in which nanoparticles dimensions vary in size. This is due to the method by which Nakajima teaches to fabricate their nanoparticles.

In view of the foregoing, the Applicants respectfully submit that the cited prior art references, Nakajima, and Black in combination with AAPA do not teach or suggest the features defined by amended independent claims 1 and 11 and as such, claims 1 and 11 are patentable over Nakajima, and Black in combination with AAPA. Further, dependent claims 2-10 and 12-19 are similarly patentable over Nakajima, and Black in combination with AAPA, not only by virtue of their dependency from patentable independent claims, respectively, but also by virtue of the additional features of the invention they define. Thus, the Applicants respectfully request

that these rejections be reconsidered and withdrawn.

Moreover, the Applicants note that all claims are properly supported in the specification and accompanying drawings, and no new matter is being added. In view of the foregoing, the Examiner is respectfully requested to reconsider and withdraw the rejections.

VI. Formal Matters and Conclusion

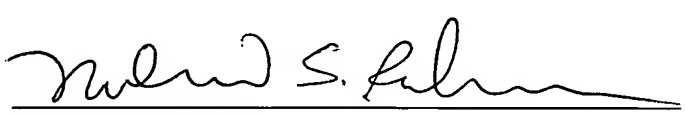
With respect to the objection to the drawings, abstract, title, and claims, the drawings, abstract, title, and claims have been amended, above, to overcome these objections. With respect to the rejections to the claims, the claims have been amended, above, to overcome these rejections. In view of the foregoing, the Examiner is respectfully requested to reconsider and withdraw the rejections to the claims.

In view of the foregoing, Applicants submit that claims 1-19, all the claims presently pending in the application, are patentably distinct from the prior art of record and are in condition for allowance. The Examiner is respectfully requested to pass the above application to issue at the earliest possible time.

Should the Examiner find the application to be other than in condition for allowance, the Examiner is requested to contact the undersigned at the local telephone number listed below to discuss any other changes deemed necessary. Please charge any deficiencies and credit any overpayments to Attorney's Deposit Account Number 50-0510.

Respectfully submitted,

Dated: July 28, 2004



Mohammad S. Rahman
Registration No. 43,029
McGinn & Gibb, P.L.L.C.

2568-A Riva Road, Suite 304
Annapolis, MD 21401
Voice: (301) 261-8625
Fax: (301) 261-8825
Customer Number: 29154